Pollution Prevention Institute

Implementation of Sustainability Improvements at the Facility Level: Business Motivations and P2 Intern Program Evaluation

Presented by: Nancy Larson

K-State Pollution Prevention Institute

August 10, 2017

Collaborators: Bruce Dvorak and Vincent D. Kuppig University of Nebraska-Lincoln;
Yvonne Cook and David Carter K-State Pollution Prevention Institute

Kansas State University

Acknowledgements

- UNL Partners in Pollution Prevention program
  - Dr. Bruce Dvorak
  - Dr. Robert Williams
  - Bonita Delhay
- KSU Pollution Prevention Institute
  - Nancy Larson
  - David Carter
  - Yvonne Cook
- Past interns and graduate students of programs
- Industry partners
- Funding: USEPA P2 Grants and NDEQ Waste Reduction Fee Fund

Pollution Prevention Institute

Kansas State University

Goals of study

- Examine two undergraduate student summer applied sustainability internship programs in neighboring Midwestern states that work with businesses and other organizations
  - University of Nebraska-Lincoln
  - Kansas State University
- Identify and understand motivations for implementation and non-implementation of pollution prevention (P2) opportunities

Strengths of programs

UNL's P3 program

- Solid waste
- Some clients in agriculture and small business sectors

Strengths of programs (continued)

KSU's PPI intern program

- Energy efficiency
  - — Energy data logger equipment
- Some clients in hospitality and health care sectors

Modes of assistance

Partial Summer

- Students spend part of the summer with a client
  - Between 3-10 clients per student intern, often similar
- Smaller businesses
- Least intense of modes

Single Summer

- Students spend an entire summer with a client
  - Often focused on one or two specific projects or areas
- Mostly manufacturing

FULL ASSISTANCE

Multiple Summer

- Similar to Single Summer, but the client works with the UNL/KSU program for multiple summers
  - Often a continued project or related project from previous summer

Methods of study

- Reassessments
  - In-person interviews
  - 1-4 years after original assistance to quantify implementation status and impact

2014 Pollution Prevention Reassessment Form (use one reassessment form for each management report/business reassessed)

Your name, number, email: John Doe, 402-555-5555, jdoe@unl.edu Date of Revisit: **June 1, 2014**

Business: Company ABC Contact name, number, email: **Jim Professional, 402-555-5255, pro@companyabc.com**

This is a reassessment of the **2010** (year) project completed by **Jack Student** (original intern).

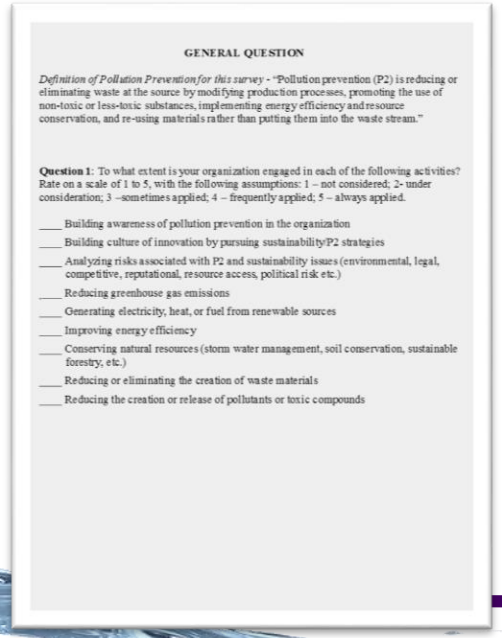
P2 Opportunity (Brief Description)	Implemented		Not Implemented			Doing Before Assessment	Comments (refer to narrative report for more information)
	As Suggested	With Modification	Investigated	Not Investigated	Don't Know		
Replace high bay lighting with T5 fluorescent in Building 3	X						Source: Electricity Implemented as suggested in 2011
Install low-flow toilets in the conference complex	X						Source: Water Implemented as suggested in 2011
Switch from pentachlorophenol to copper naphthenate for treating wood	X						Source: Hazardous Waste Implemented as suggested in 2012
Replace T12 office lighting with T8 fluorescent				X			Source: Electricity Client indicated office lighting has not been a high priority
Install geothermal pump in Building 3				X			Source: Natural gas Opportunity was not recommended because of lengthy payback period.
Upgrade wastewater evaporator when current one needs to be replaced				X			Source: Natural gas Opportunity was not recommended at this time – only when current evaporator needs to be replaced in 2016

Pollution Prevention Institute

Kansas State University

Methods of study

- Survey
    1. General question: Levels of engagement in P2 activities
    2. Specific questions: Motivations for implementation
    3. Specific questions: Justifications for non-implementation

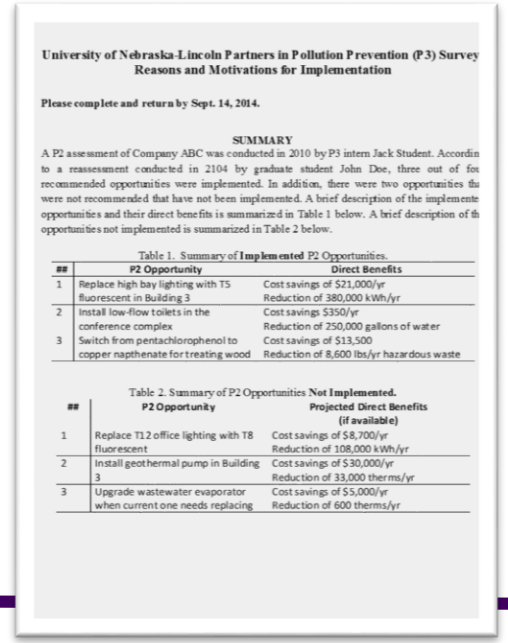


GENERAL QUESTION

Definition of Pollution Prevention for this survey - "Pollution prevention (P2) is reducing or eliminating waste at the source by modifying production processes, promoting the use of non-toxic or less-toxic substances, implementing energy efficiency and resource conservation, and re-using materials rather than putting them into the waste stream."

Question 1: To what extent is your organization engaged in each of the following activities? Rate on a scale of 1 to 5, with the following assumptions: 1 – not considered; 2- under consideration; 3 –sometimes applied; 4 – frequently applied; 5 – always applied.

___ Building awareness of pollution prevention in the organization
___ Building culture of innovation by pursuing sustainability/P2 strategies
___ Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)
___ Reducing greenhouse gas emissions
___ Generating electricity, heat, or fuel from renewable sources
___ Improving energy efficiency
___ Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)
___ Reducing or eliminating the creation of waste materials
___ Reducing the creation or release of pollutants or toxic compounds



University of Nebraska-Lincoln Partners in Pollution Prevention (P3) Survey
Reasons and Motivations for Implementation

Please complete and return by Sept. 14, 2014.

SUMMARY

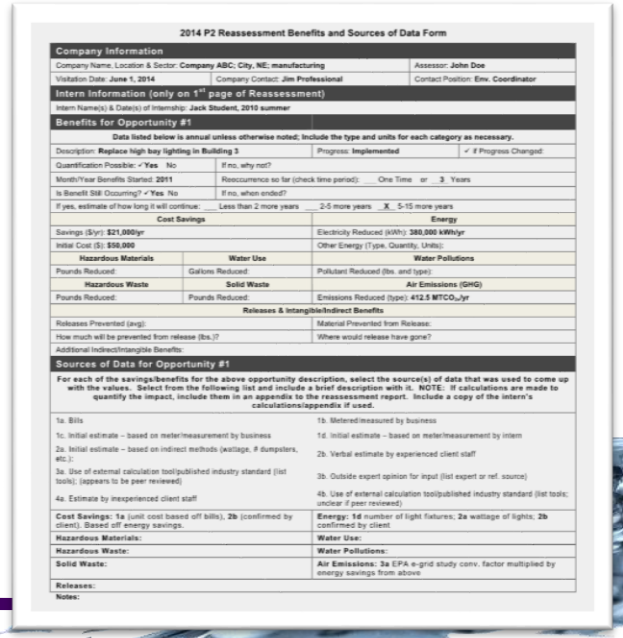
A P2 assessment of Company ABC was conducted in 2010 by P3 intern Jack Student. Accordin to a reassessment conducted in 2104 by graduate student John Doe, three out of fo recommended opportunities were implemented. In addition, there were two opportunities th were not recommended that have not been implemented. A brief description of the implemente opportunities and their direct benefits is summarized in Table 1 below. A brief description of th opportunities not implemented is summarized in Table 2 below.

Table 1. Summary of **Implemented** P2 Opportunities.

##	P2 Opportunity	Direct Benefits
1	Replace high bay lighting with T5 fluorescent in Building 3	Cost savings of $21,000/yr Reduction of 380,000 kWh/yr
2	Install low-flow toilets in the conference complex	Cost savings $350/yr Reduction of 250,000 gallons of water
3	Switch from pentachlorophenol to copper napthenate for treating wood	Cost savings of $13,500 Reduction of 8,600 lbs/yr hazardous waste

Table 2. Summary of P2 Opportunities **Not Implemented.**

##	P2 Opportunity	Projected Direct Benefits (if available)
1	Replace T12 office lighting with T8 fluorescent	Cost savings of $8,700/yr Reduction of 108,000 kWh/yr
2	Install geothermal pump in Building 3	Cost savings of $30,000/yr Reduction of 33,000 therms/yr
3	Upgrade wastewater evaporator when current one needs replacing	Cost savings of $5,000/yr Reduction of 600 therms/yr



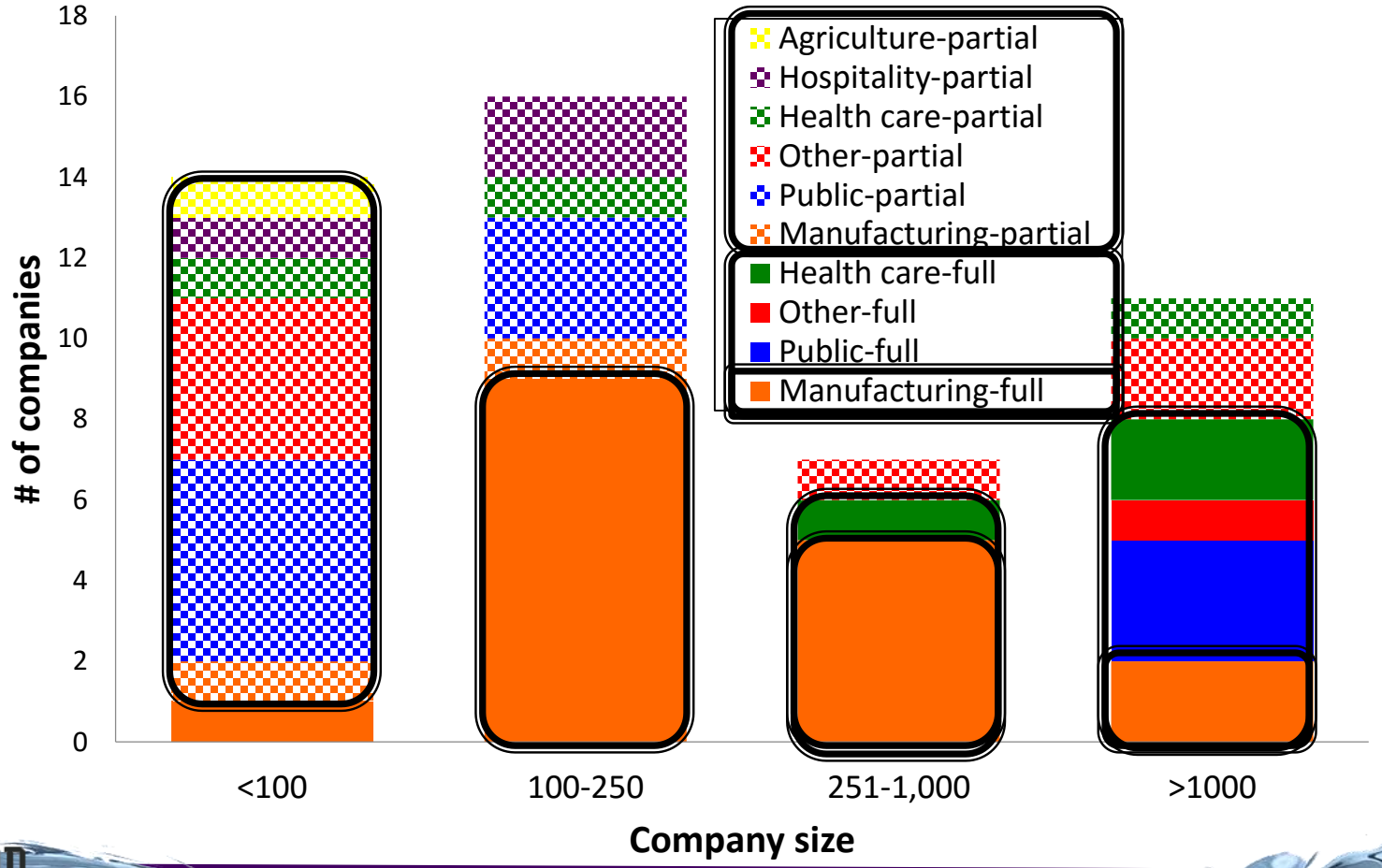
2014 P2 Reassessment Benefits and Sources of Data Form

Company Information		
Company Name, Location & Sector: **Company ABC; City, NE; manufacturing**		Assessor: **John Doe**
Visitation Date: **June 1, 2014**	Company Contact: **Jim Professional**	Contact Position: **Env. Coordinator**
Intern Information (only on 1st page of Reassessment)		
Intern Name(s) & Date(s) of Internship: **Jack Student, 2010 summer**		
Benefits for Opportunity #1		
Data listed below is annual unless otherwise noted; Include the type and units for each category as necessary.		
Description: **Replace high bay lighting in Building 3**	Progress: **Implemented**	✓ if Progress Changed:
Quantification Possible: ✓**Yes** No	If no, why not?	
Month/Year Benefits Started: **2011**	Reoccurrence so far (check time period): ___ One Time or **_3_** Years	
Is Benefit Still Occurring? ✓**Yes** No	If no, when ended?	
If yes, estimate of how long it will continue: ___ Less than 2 more years ___ 2-5 more years **_X_** 5-15 more years		
Cost Savings		**Energy**
Savings ($/yr): **$21,000/yr**		Electricity Reduced (kWh): **380,000 kWh/yr**
Initial Cost ($): **$50,000**		Other Energy (Type, Quantity, Units):
Hazardous Materials	**Water Use**	**Water Pollutions**
Pounds Reduced:	Gallons Reduced:	Pollutant Reduced (lbs. and type):
Hazardous Waste	**Solid Waste**	**Air Emissions (GHG)**
Pounds Reduced:	Pounds Reduced:	Emissions Reduced (type): **412.5 MTCO$_2$e/yr**
Releases & Intangible/Indirect Benefits		
Releases Prevented (avg):		Material Prevented from Release:
How much will be prevented from release (lbs.)?		Where would release have gone?
Additional Indirect/Intangible Benefits:		
Sources of Data for Opportunity #1		
For each of the savings/benefits for the above opportunity description, select the source(s) of data that was used to come up with the values. Select from the following list and include a brief description with it. NOTE: If calculations are made to quantify the impact, include them in an appendix to the reassessment report. Include a copy of the intern's calculations/appendix if used.		
1a. Bills		1b. Metered/measured by business
1c. Initial estimate – based on meter/measurement by business		1d. Initial estimate – based on meter/measurement by intern
2a. Initial estimate – based on indirect methods (wattage, # dumpsters, etc.):		2b. Verbal estimate by experienced client staff
3a. Use of external calculation tool/published industry standard (list tools); (appears to be peer reviewed)		3b. Outside expert opinion for input (list expert or ref. source)
4a. Estimate by inexperienced client staff		4b. Use of external calculation tool/published industry standard (list tools; unclear if peer reviewed)
Cost Savings: 1a (unit cost based off bills), **2b** (confirmed by client). Based off energy savings.		**Energy: 1d** number of light fixtures; **2a** wattage of lights; **2b** confirmed by client
Hazardous Materials:		**Water Use:**
Hazardous Waste:		**Water Pollutions:**
Solid Waste:		**Air Emissions: 3a** EPA e-grid study conv. factor multiplied by energy savings from above
Releases:		
Notes:		

Pollution Prevention Institute

Kansas State University

Overview of surveyed companies by sector



Pollution Prevention Institute

Kansas State University

Results:
P2 intern assistance programs

Pollution Prevention Institute

Kansas State University

Implementation rate

Mode of assistance/ Program	Partial summer	Single summer	Multiple summer	Total
KSU	39% (6/31)	62% (5/13)	64% (6/74)	57% (17/118)
UNL	42% (23/187)	49% (10/99)	58% (5/100)	48% (38/386)
Total	**41%** (29/218)	**51%** (15/112)	**60%** (11/174)	**50%** (55/504)

(Number of clients/recommendations in parentheses)

"Full" implementation rate = 57%

50% similar to other programs in literature

*Statistically significant relation between assistance and implementation rate (Chi-square = 14.1, p = 0.0009)

*No statistically significant difference (dependent on assistance)

Pollution Prevention Institute

Kansas State University

Impact by mode of assistance

Impact/ Assistance	Measure-ment	Cost savings $/yr	Electricity kWh/yr	Natural gas therms/yr	Solid waste lbs/yr	Water gal/yr
Full (30)	Total	$2,727,626	9,183,980	555,273	24,243,850	34,983,500
	Average	$90,921	306,132	18,509	808,128	1,116,117
	Median	$46,209	69,914	0	0	0
Partial (17)	Total	$108,169	1,086,248	6,800	31,400	49,892,505
	Average	$6,363	63,914	400	1,847	2,934,853
	Median	$2,136	10,307	0	0	0
Total (47)	Total	$2,835,795	10,270,228	562,073	24,275,250	84,876,005
	Average	$60,336	218,515	11,959	516,495	1,805,872
	Median	$20,300	21,000	0	0	0

(Number of client summers in parentheses)

- Companies implementing sustainability opportunities on their own after assistance
  - Outdoor LEDs: $330,000 & 3.7 million kWh annually
  - Water vacuum pump to closed oil pump: $120,000 and 4 million gallons of water annually

Likert scale: 1-to-5 (1 – not considered; 3 – sometimes applied; 5 – always applied)

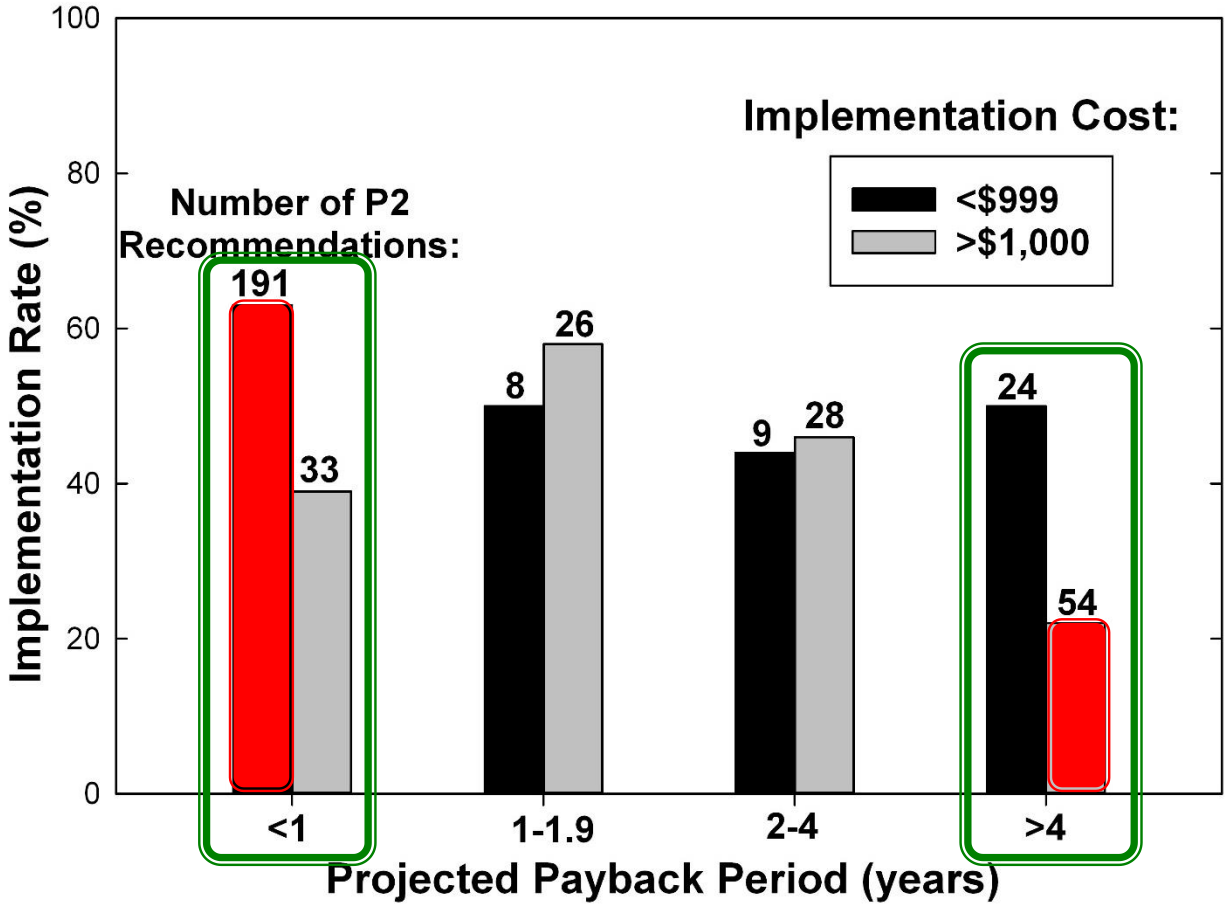
Engagement Activity	Responses to other surveys		Total (48)	Survey responses by sector				
	MIT (3,107)	GTP (35,000)		Health care (6)	Hospi-tality (3)	Manu-fact-uring (19)	Other (8)	Public (10)
Reducing or eliminating the creation of waste materials	3.69	55%	**3.6**	2.5	3.3	4.2	3.3	3.4
Improving energy efficiency	3.69	57%	**3.9**	4.0	4.3	4.3	2.7	4.1
Reducing the creation or release of pollutants or toxic compounds	n/a	13%	**3.7**	3.2	3.3	4.2	3.0	3.5
Conserving natural resources (storm water management, soil conservation, sustainable forestry, etc.)	n/a	19%	**3.2**	3.0	2.3	3.7	2.6	3.1
Analyzing risks associated with P2 and sustainability issues (environmental, legal, competitive, reputational, resource access, political risk etc.)	3.1	n/a	**3.4**	2.8	3.7	3.8	2.6	3.2
Building awareness of pollution prevention in the organization	3.22	n/a	**3.4**	3.5	3.7	3.6	2.8	3.5
Reducing greenhouse gas emissions	2.83	13%	**3.0**	3.3	3.3	3.3	2.3	2.6
Building culture of innovation by pursuing sustainability/P2 strategies	3.06	n/a	**3.1**	3.3	3.3	3.1	2.9	3.2
Generating electricity, heat, or fuel from renewable sources	n/a	2%	**2.0**	1.8	1.3	1.9	2.0	2.0
Average			**3.3**	3.1	3.2	3.6	2.7	3.2

*Statistically significant differences from combined totals of the rest of the sectors

Pollution Prevention Institute

Kansas State University

Implementation rate by payback/initial cost



Implementation rate highest at low cost, short payback; lowest at high cost, long payback.

*Statistically significant differences

But other factors are important.

Pollution Prevention Institute

Kansas State University

The Survey: Motivations

Social Health/Compliance Financial Feasibility Personnel Other

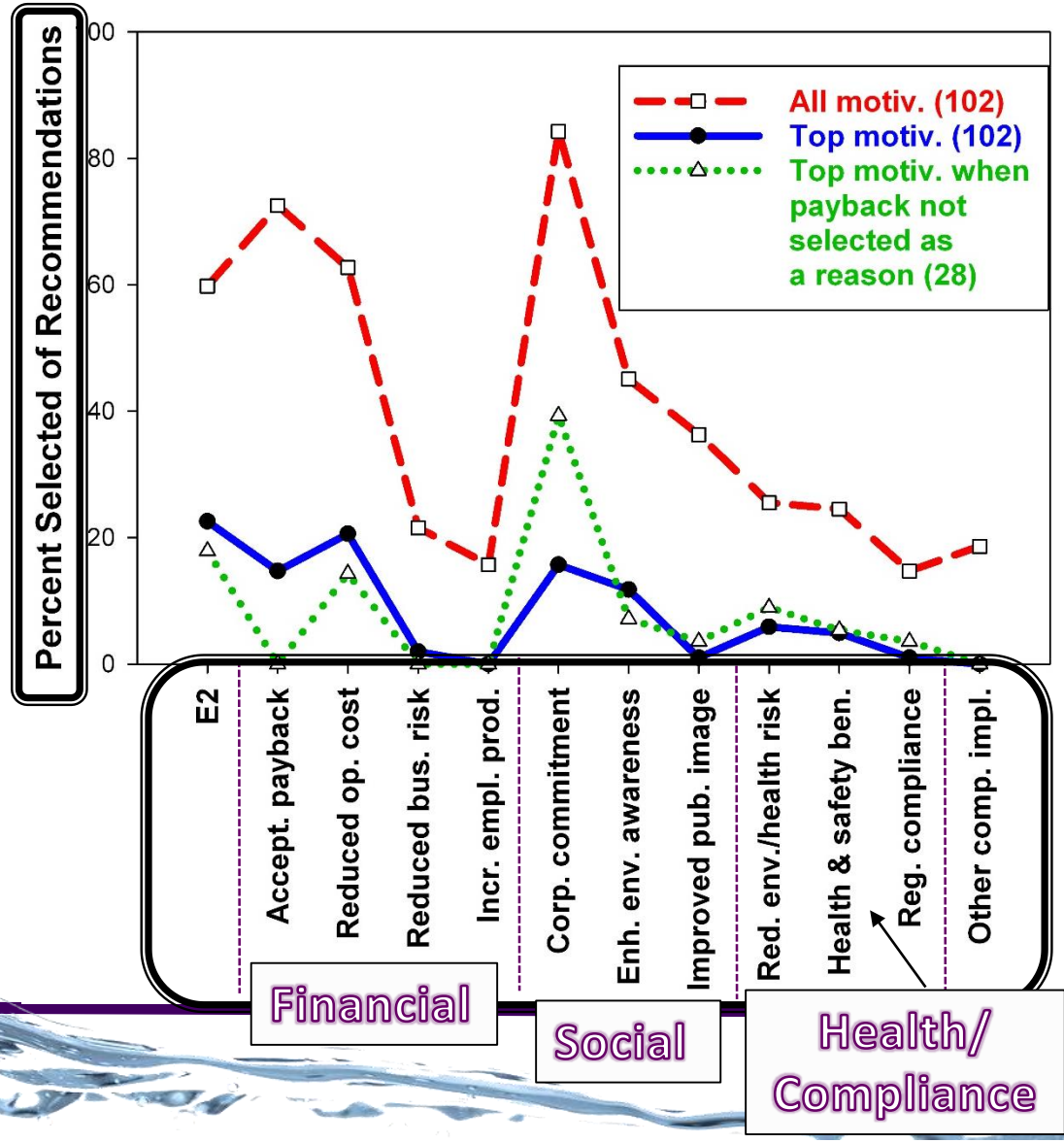
Implementation

- Acceptable payback period
- Energy efficiency
- Reduced operating cost
- Increased employee productivity
- Health and safety benefits
- Regulatory compliance
- Reduced environmental and health risk (spills, vapors, liability etc.)
- Reduced business risk (impact of changes in regulation, input costs etc.)
- Enhanced environmental awareness
- Improved public image
- Other companies also implemented the same or similar solution
- Corporate commitment to resource use/waste reduction

Non-implementation

- Not technically feasible
- Lack of capital (financing)
- Insufficient financial payback
- Other priorities for capital investments
- Risk of production disruption/inconvenience/slowdown
- Lack of perceived environmental/risk reduction benefits
- Limited in-plant expertise/capability
- Lack of staff awareness/willingness to change
- Customer specifications
- Uncertainty/lack of confidence in technology (quality, cost, benefits)
- Insufficient information regarding recommendation
- Difficulty in coordinating between units within company

Motivations for implementation



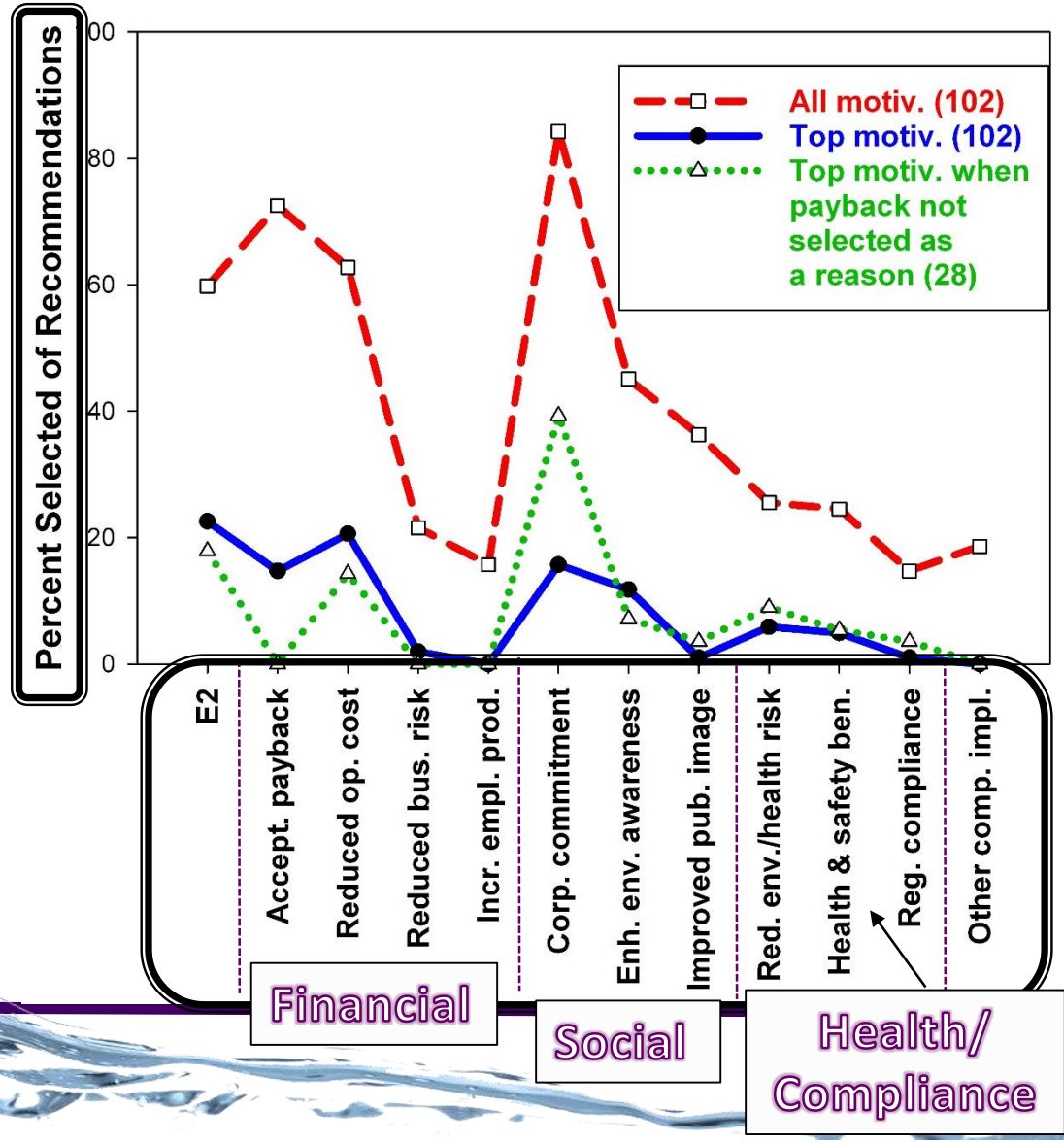
Top reasons

- Energy efficiency (23%)
- Reduced operating cost (21%)
- Corporate commitment (16%)
- Acceptable payback (15%)
- Enhanced environmental awareness (12%)

Pollution Prevention Institute

Kansas State University

Motivations for implementation



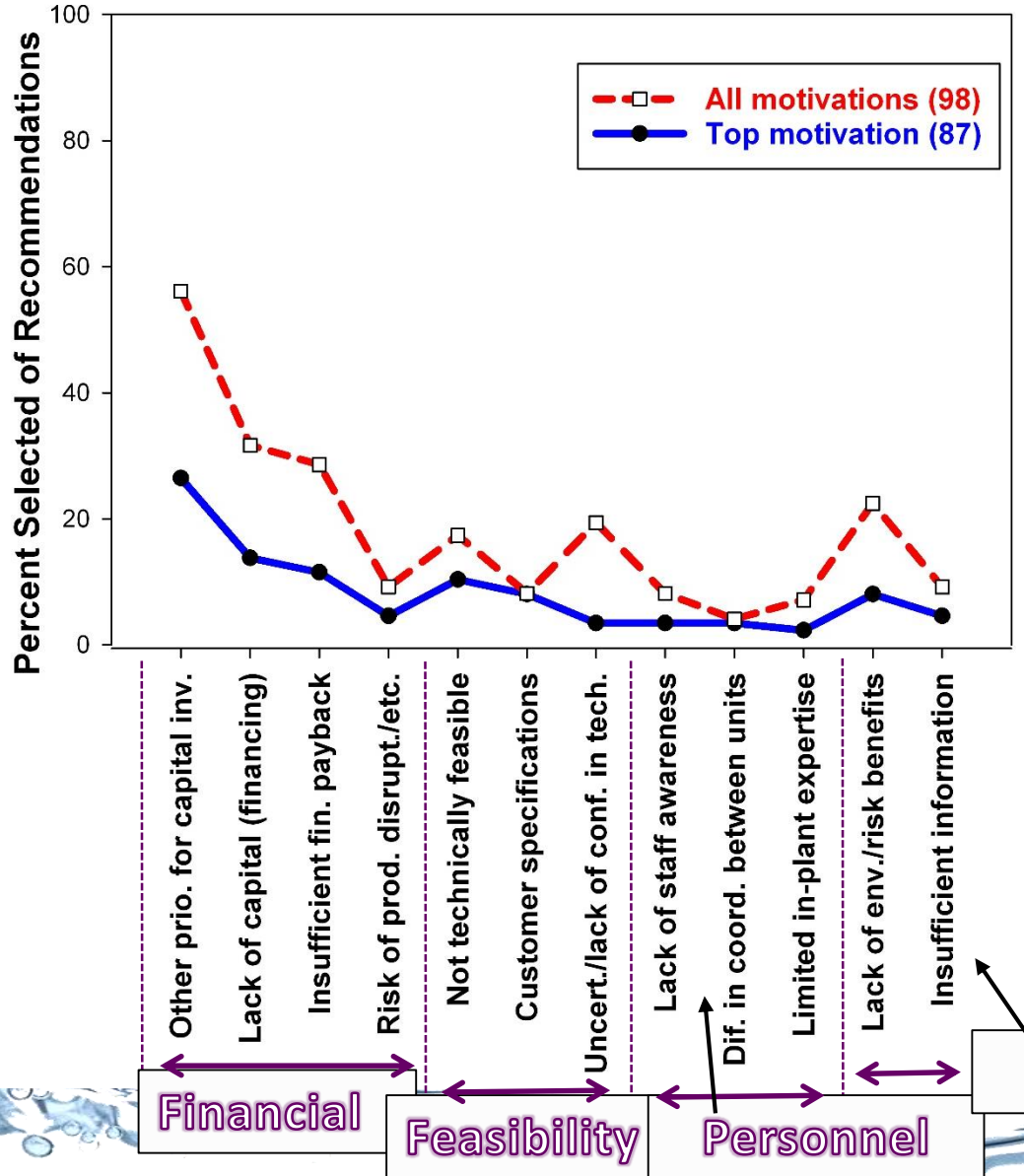
All reasons

- Corporate commitment (84%)
- Acceptable payback (73%)
- Reduced operating cost (63%)
- Energy efficiency (60%)
- Enhanced environmental awareness (45%)
- Improved public image (36%)

Pollution Prevention Institute

Kansas State University

Motivations for non-implementation



Top reasons (all)

- Other priorities for capital investments: 26% (56%)
- Lack of capital: 14% (32%)
- Insufficient financial payback: 11% (29%)
- Not technically feasible: 10% (17%)
- Lack of perceived environment/ risk reduction benefits: 8% (22%)
- Customer specifications: 8% (8%)

Number of reasons

Implemented	Not Implemented
4.8	2.2

Pollution Prevention Institute

Kansas State University

Financial motivations by initial cost & payback period

Top motivation is financial: Non-implemented recommendations

Initial cost/ Payback	<$1,000	≥$1,000	Total
<1 year (# recomm.)	26% (23)	83% (12)	46% (35)
≥1 year (# recomm.)	40% (5)	71% (34)	67% (39)
Total (# recomm.)	26% (31)	74% (46)	56% (87)

Note: Several recommendations had unknown initial costs and/or paybacks, or initial costs and cost savings of $0; they are included in the totals in the table above but are not pulled out separately.

*Statistically significant relationship between initial cost/payback categories and percent financial motivations were given.

Conclusions

- Clients reassessed were slightly more active than a national study in sustainability
  - Full more than partial
  - Manufacturing most engaged of sectors
- Full assistance implemented at higher percentage than partial, and had a greater impact (savings)

Conclusions (continued)

- Improved housekeeping/preventative maintenance implemented at highest percentage
  - Training/policies higher for full assistance
- Persistence of benefits was expected to occur for at least 5 years
- Recommendations with low cost, short payback implemented at a higher rate, but other factors important

Conclusions (continued)

- More motives for implementation than non-implementation
- Finances less of a motivation than a barrier
  - Capital more of a barrier than poor payback
  - Finances least important for public sector
  - Finances most important for equipment/process modification, least important for training/policies

Conclusions (continued)

- Other indirect, intangible benefits important
- Social motives especially important for recycling, training/policies
- Health/compliance important for recommendations that reduce toxins

Questions?

Pollution Prevention Institute

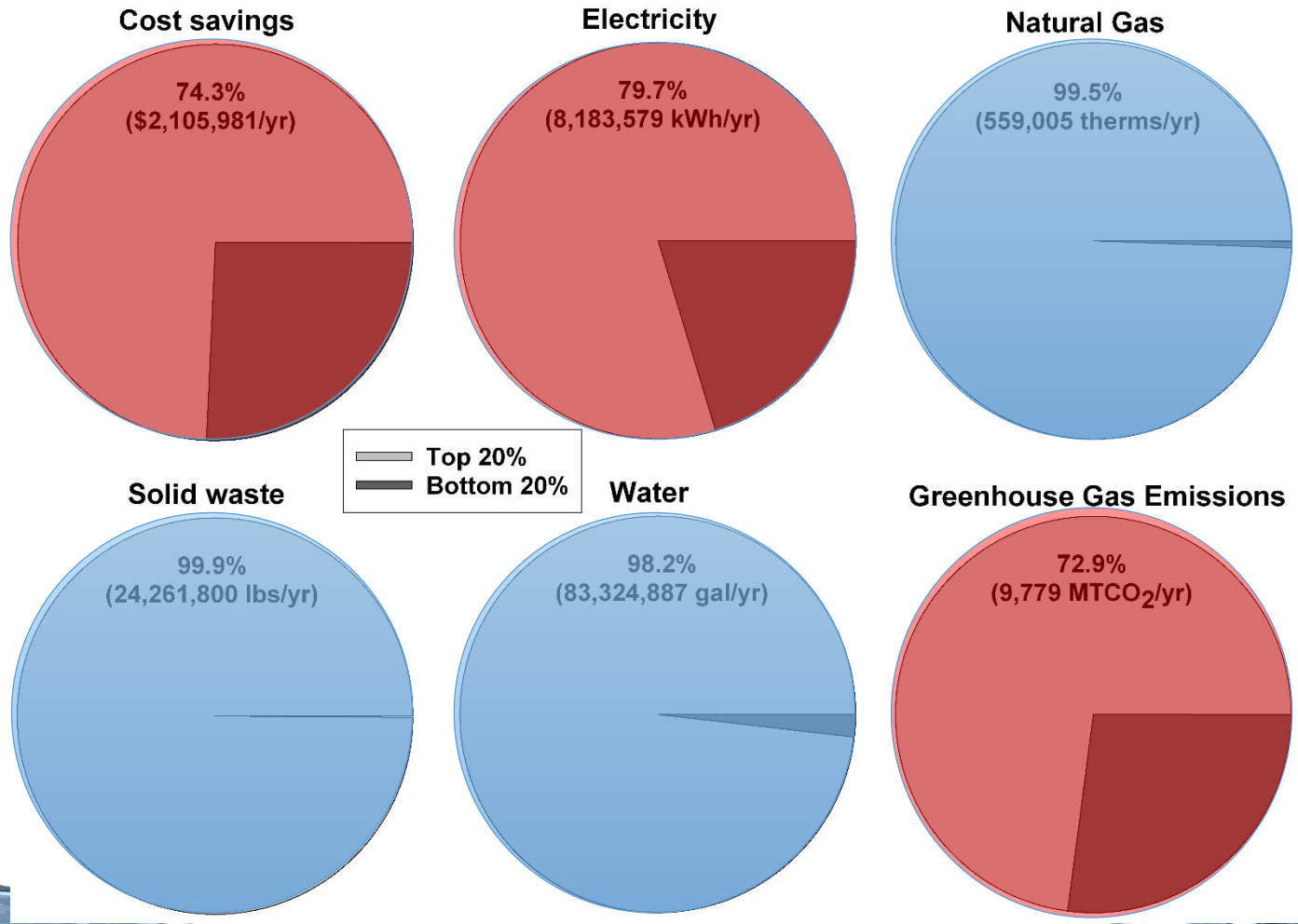
Kansas State University

Additional slides

Pollution Prevention Institute

Kansas State University

Impact: Pareto analysis (80-20 rule) by client



Pollution Prevention Institute

Kansas State University